Case-control Study on the Prevention of Occupational Eye Injuries

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The risk factors for occupational eye injuries have never been published in Taiwan. We conducted a case-control study to analyze the differences among workers on their knowledge, attitude to and practice (KAP) of occupational accident prevention. In the study, a statistical model was also set up for predicting the occupational problem. Subjects, including 31 cases of work-related eye injuries and 62 controls, completed a structured questionnaire on KAP, which revealed that 80.6% and 62.7% of workers in the case and control groups, respectively, did not wear eye protection during work. Furthermore, we found that temporary employment (OR, 10.7; 95% CI, 3.03–36.16) and fewer than 10 years of education (OR, 4.44; 95% CI, 1.73–11.44) were the major risk factors for occupational eye injuries. In addition, we developed a logistic regression model with four predictors (temporary employment, education years less than 10, poor management of industrial health and safety in the workplace, and poor attitude towards accident prevention) for the occurrence of occupational eye injuries. In conclusion, in Taiwan, compulsory regulation of wearing eye protection during work, good education, management of work safety and hygiene and employee (especially temporary worker) commitment to safety and health are strongly recommended prevention strategies.

Key Words: attitude, knowledge, occupational eye injuries, practice, temporary employment
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Occupational eye injuries can result in serious morbidity and great economic loss. Employees in every industry are at risk of eye injuries. According to the Occupational Safety and Health Act (OSHA) of the US in 1971, employers are required to make protection available, and it is the employees' obligation to use the equipment provided. However, in the US, the Bureau of Labor Statistics (BLS) reports that approximately three out of every five workers injured were either not wearing eye protection at the time of the accident or were wearing the wrong kind of eye protection for the job [1]. Despite regulations, standards, and the various items of eye protection equipment provided, occupational eye injuries remain a common occurrence [2].

The Labor Injuries Surveillance Data in Taiwan do not provide information on eye injuries; therefore,

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we do not know how serious the problem is. Although eye injury is considered to be an important cause of vision loss, little information exists concerning the risk factors and strategies for prevention.

Many safety professionals recognize that the proper use of eye protection is very important for the prevention of eye injuries. However, there could still be other factors that influence the likelihood of injury to employees. Our study aimed to explore risk factors through a comparison of the differences in health and safety perceptions between subjects in case (work-related eye injuries) and control groups, and develop statistical models for predicting the occurrence of occupational eye injuries. We hope to provide information for the further development of sound prevention programs.

METHODS

Subjects and study design

We conducted a prospective hospital-based case-control study from January 1, 2003 to December 31, 2004 among patients of an ophthalmology ward in an academic medical center in Kaohsiung city in southern Taiwan. During the 2-year study period, 31 out of 189 cases diagnosed as having work-related eye injuries agreed to join the study, and completed a structured questionnaire on the management of health and safety in their workplace.

To match the 31 cases of work-related eye injuries, we selected 62 subjects (2 controls per case) currently enrolled in the Labor Insurance Program as a control group. The criteria for matching the case and control groups were as follows: (1) patients who had been admitted to the ophthalmology ward without past history of eye injuries; (2) same gender; (3) an age difference of less than 5 years (±5 years); and (4) similar occupations. The discharge records of subjects in the case and control groups were reviewed carefully to obtain data on age, sex, date of admission, cause of admission and clinical diagnosis. The criteria for inclusion and exclusion of cases of occupational eye injuries were adapted from our previous study [3].

In the current study, we classified the industries in which study subjects were employed as follows:

- Class I: agriculture, forestry, fishing and animal husbandry
- Class II: manufacturing
- Class III: electricity, gas and water supply
- Class IV: construction
- Class V: trade, accommodation, eating-drinking places, transportation, storage and communication
- Class VI: services

Content of questionnaire

The structured questionnaire was designed to collect basic data, including occupation and employment status. The questionnaire also addressed the employer's strategies and management of industrial safety and hygiene in the workplace, and the knowledge, attitude to and practice (KAP) of accident prevention. The answer to each question was selected from "never", "not always" and "always", and was rated as 0, 1 and 2 points, respectively. We summed up the points of answers for questions about KAP as total scores for each item separately. The questionnaire was pre-tested and adjusted for validity by occupational medicine specialists.

Statistical analysis

In our study, SPSS version 13.0 (SPSS Inc., Chicago, IL, USA) was used to set up the database and perform analyses. As age, gender and occupation were well matched between case and control groups, these factors were neglected during analysis of risk factors of occupational eye injuries. Other factors, such as years of education, employment status, duration of employment and fringe benefits, were analyzed by comparing the odds ratios (ORs) between these two groups. The effects of the management of health and safety in workplaces and KAP scores of accident prevention on the occurrences of occupational eye injuries among case and control groups were also compared by analyses of ORs.

Some potential predictors, such as employment status, education years, fringe benefits, scores of poor management, poor knowledge, poor attitudes and poor practice, were analyzed by simple regression to find correlations with occupational eye injuries. Then, we put the variables of employment, education years, management of health and safety and attitudes towards health and safety into logistic regression analysis models to determine predictors of occupational eye injuries. Finally, logistic regression models with backward stepwise analyses were performed to set up a suitable model for predicting the risks for occupational eye injuries.

RESULTS

Characteristics of the subjects studied

Among the subjects studied, male workers represented 83.9% of both study groups; the average ages were 42.8 ± 10.7 and 41.8 ± 10.5 for case and control groups, respectively, as shown in Table 1. Most subjects were employed in the construction (38.7% and 43.5% for case and control groups, respectively) and manufacturing (32.3% and 33.9% for case and control groups, respectively) industries. Subjects in class III occupations, such as electricity, gas and water, showed lower probabilities of suffering from occupational eye injuries than subjects in other classes of occupation (OR, 0.64; 95% confidence interval [CI], 0.55–0.75). Subjects in occupational class VI, services, showed a 4.23-fold likelihood of suffering from occupational eye injuries (OR, 4.23; 95% CI, 1.13–15.79) when compared with subjects of occupations other than class VI. Workers who had fewer than 10 years of education showed a 4.44-fold higher possibility of occupational eye injuries than those with education years greater than or equal to 10 years (OR, 4.44; 95% CI, 1.73–11.44). Compared with permanently employed workers, temporary workers had a 10.7-fold (95% CI, 3.03–36.16) increased likelihood of experiencing occupational eye injuries. Durations of employment and fringe benefits provided by the employers, except for health insurance, did not show correlations with occupational injuries. However, it seems that workers with health insurance provided by the employers had lower probabilities of suffering occupational eye injuries (OR, 0.26; 95% CI, 0.08–0.82).

Effects of KAP of industrial safety and hygiene on eye injuries

The responses to questionnaires on the management of industrial health and safety in the workplace, shown

Table 1. Characteristics of subjects in the case and control groups*

	Case (N = 31)	Control (N = 62)	OR	95% CI
Gender			NA	
Male	26 (83.9)	52 (83.9)		
Female	5 (16.1)	10 (16.1)		
Age	42.8 ± 10.7	41.8 ± 10.5	NA	
Occupations				
Class I	1 (3.2)	1 (1.6)	2.03	0.12–33.64
Class II	10 (32.3)	21 (33.9)	0.93	0.37–2.33
Class III	0 (0.0)	6 (9.7)	0.64	0.55–0.75
Class IV	12 (38.7)	27 (43.5)	0.82	0.34–1.97
Class V	1 (3.2)	3 (4.8)	0.66	0.07–6.57
Class VI	7 (22.6)	4 (6.5)	4.23	1.13–15.79
Education years				
< 10	16 (51.6)	12 (19.4)	4.44	1.73–11.44
≥ 10	15 (49.4)	50 (80.6)	1	
Employment				
Permanent	18 (58.1)	58 (93.5)	1	
Temporary	13 (41.9)	4 (6.5)	10.7	3.03–36.16
Duration of employment (yr)				
< 5	7 (22.6)	27 (43.6)	2.81	0.91–7.31
5–10	8 (25.8)	11 (17.7)	2.57	0.82–9.63
> 10	16 (51.6)	24 (38.7)	1	
Fringe benefits				
Labor insurance	25 (80.6)	50 (80.6)	1	0.34–2.98
Health insurance	22 (71.0)	56 (90.3)	0.26	0.08–0.82
Insurance for accidents	15 (48.4)	37 (59.7)	0.63	0.21–1.51

*Data are presented as n (%), with the exception of age which is presented as mean ± standard deviation. NA = not analyzed as gender and age were matched between case and control groups; Class I = agriculture, forestry and fishing; Class II = manufacturing; Class III = electricity, gas and water; Class IV = construction; Class V = trade, accommodation, eating-drinking places, transportation, storage and communication; Class VI = services.

in Table 2, showed that good management has a protective effect against occupational eye injuries. Workplaces in which the employer offered job safety and hygiene training courses regularly showed lower possibilities of eye injuries (OR, 0.14; 95% CI, 0.05–0.37). Workplaces in which employers provided control measures for potential risks (OR, 0.35; 95% CI, 0.14–0.87) or offered regular medical check-ups for workers as required by law (OR, 0.17; 95% CI, 0.06–0.46) had fewer occupational eye injury cases than workplaces that were not well managed. However, no protective effect could be found for eye injuries whether an employer required their workers to wear eye protection during work or not (OR, 0.50; 95% CI, 0.18–1.42).

The correct answer rates of knowledge of accident prevention were similar between case and control groups, as shown in Table 2. Workers in case and control groups know that they have to understand the potential risks of hazardous materials in a new workplace (71.0% *vs.* 79.0%), to understand the standard operating procedures of machine and hand tool use (83.9% *vs.* 79.0%), to know the emergency and evacuation plans (71.0% *vs.* 69.4%), and to know the measures of the Labor Safety and Hygiene Act (66.7% *vs.* 66.1%). There were no statistically significant differences in the ORs for any item of knowledge of accident prevention.

Subjects in case and control groups showed no differences in the rates of positive attitudes toward

Table 2. Responses to questionnaire on the management of health and safety, as well as knowledge, attitude to and practice of health and safety in workplaces*

	Case ($N=31$)	Control ($N=62$)	OR	95% CI
Management of health and safety				
Offer job safety and hygiene training courses regularly	13 (41.9)	52 (83.9)	0.14	0.05–0.37
Provide control measures or equipment for potential risk factors in the workplace	15 (48.4)	45 (72.6)	0.35	0.14–0.87
Require workers to wear eye protection during work	6 (19.4)	20 (32.3)	0.50	0.18–1.42
Offer medical check-ups or regular medical examinations as required by law	7 (22.6)	39 (62.9)	0.17	0.06–0.46
Knowledge of accident prevention				
Know the potential risks of hazardous materials in a new workplace	22 (71.0)	49 (79.0)	0.65	0.24–1.74
Understand the standard operating procedure of machine and hand tool use	26 (83.9)	49 (79.0)	1.38	0.44–4.29
Know the emergency and evacuation plan of the workplace	22 (71.0)	43 (69.4)	1.08	0.42–2.78
Know the measures of the Labor Safety and Hygiene Act	20 (66.7)	41 (66.1)	1.02	0.41–2.58
Attitudes toward accident prevention				
Agree that accidents could be mainly due to mistakes	23 (74.2)	34 (54.8)	2.37	0.92–6.11
Easily accept any safety advice given by colleagues	26 (86.7)	60 (96.8)	0.22	0.04–1.26
Practices of accident prevention				
Use personal protective devices during exposure to hazards	13 (41.9)	43 (69.4)	0.32	0.13–0.78
Stop work when feeling ill	17 (54.8)	46 (79.0)	0.42	0.17–1.05
Clean machine or hand tools before use	22 (71.0)	40 (64.5)	1.34	0.53–3.42
Indicate safety and hygiene problems immediately to the workplace supervisor	16 (51.6)	42 (67.7)	0.51	0.21–1.23

*Data are presented as *n* (%).

Table 3. Logistic regression model for predictors of occupational eye injuries*

Predictors	Adjusted OR	95% CI
Employment: 0 = permanent, 1 = temporary	7.55	1.86–30.58
Education years: 0 = ≥ 10, 1 = < 10	3.30	1.02–10.68
Management of health and safety: 0 = scores > 3, 1 = scores < 3	3.95	1.26–12.44
Attitudes toward health and safety: 0 = scores > 1, 1 = scores < 1	3.57	1.10–11.59

*A backward stepwise regression analysis was used to construct the logistic regression model. OR = odds ratio; CI = confidence interval.

accident prevention. All of the items of practice of accident prevention, except for one, showed similar positive answer rates between case and control groups. In the control group, 69.4% of subjects used personal protective devices during exposure to hazards. However, 41.9% of workers in the case group had performed the same practices as the control group (OR, 0.32; 95% CI, 0.13–0.78). It was surprising to find that there were no statistically significant differences among the answers regarding most items of KAP between the case and control groups.

Predictors of occupational eye injuries

After conditional backward stepwise analysis, a logistic regression model was constructed as shown in Table 3. The logistic regression model showed that temporary employment status, fewer than 10 education years, poor management of health and safety in the workplace, and poor attitudes towards accident prevention were major risk factors for occupational injuries. Among these four risk factors, temporary employment status was the highest weighted. The adjusted OR and 95% CI of this predictor were 7.55 and 1.86–30.58, respectively.

DISCUSSION

Strengthen the regulation of wearing eye protection during work

The current study provided valuable insight into the strategies and management of safety and hygiene in workplaces in Kaohsiung city, Taiwan. The study revealed that 80.6% and 62.7% of subjects in the case and control groups, respectively, did not wear eye protection during work. The Council of Labor of the Taiwan government has not enacted a rule like the OSHA of the US to require the use of eye protection during work. Since most occupational accidents could have been avoided with better protective devices, a regulation for their compulsory use in the workplace is urgently needed.

Temporary workers and fewer education years

To our knowledge, this is the first case-control study investigating the relationships between safety perception and vocational behaviors and the occurrence of occupational eye injuries in Taiwan. The data are important for developing strategies and measures for work-related eye injury prevention.

In the current study, we found that temporary workers are the most important and specific target for occupational eye injury prevention. However, as shown in previous studies [4,5], temporary workers usually have a high turnover rate, low safety consciousness and poor work quality, and they are hard to manage. In Taiwan, many workplaces are usually of medium to small scale, often with a lack of good human resources management. Even in large companies, many tasks are contracted out for cost reasons. Due to contract periods that differ in duration, temporary workers are usually hired to cope with the high turnover rate. The education years of temporary workers are lower and they are usually assigned miscellaneous jobs. This, combined with worse fringe benefits, causes the accident rate for temporary workers to be higher than that for permanent employees.

Due to problems of managing temporary workers, even having a regulation on compulsory wearing of eye protection may have no effect. It is suggested that temporary workers, regardless of whether they are hired by a third-party vendor or directly by the company, be put into the same managerial system as the permanent workers in the company. Safety and hygiene managers and their employers should be responsible for inspecting the working conditions of temporary workers.

Strategies of occupational eye injuries prevention in Taiwan

We were surprised to find that knowledge of accident prevention had no effect on the incidence of occupational eye injuries. Moreover, scores of knowledge on accident prevention showed no statistical difference between subjects in the case and control groups. On the other hand, poor attitudes toward accident prevention are an important predictor of occupational eye injuries. It seemed that most of our workers were educated on accident prevention in the workplace, and also knew how to practice the prevention measures in the workplace. Only those workers with poor attitudes towards accident prevention were candidates for eye injuries. This is unusual when compared with studies in other countries [6–9]. Hence, developing a health and safety culture in work environments in Taiwan is an important issue. This proposal is compatible with the finding in the current study that poor management of health and safety in the workplace results in more patients with occupational eye injuries. As indicated by Bailey [8,9], employee perceptions of the management's commitment to safety were highly positive in plants with low injury rates. On the other hand, in plants where injury rates were high, employee perceptions of the management's commitment to safety were low. Further studies on the development of good management of health and safety in the workplace to reduce occupational eye injuries should be performed.

Limitations of the study

Our study, like most studies on occupational eye injuries, is a hospital-based epidemiological study. Eye injury patients were only recruited from an academic medical center in Kaohsiung. These might not represent all eye injuries in Taiwan. Although cases and controls were selected randomly from admissions during the 2-year study period, the response rate was only around 50%. Thirty-one cases out of 62 occupational eye injury admissions agreed to join the study, so a self-selection bias could occur. Hospital-based studies entail limitations for data interpretation, but generalizations may be drawn from them regarding the relative weight of various causes of injury. Furthermore, the case-control study design of the present study can help to detect patterns of factors influencing eye injuries in workplaces more precisely.

To minimize bias, trained interviewers went to the bedside to explain the purpose of the study and how to answer questions in a standardized manner. Patients completed the questionnaire themselves during hospitalization or after discharge. Although non-responders were followed up by telephone, many cases were still lost. We performed tests to examine the representative ability of the subjects in the case group with the 189 cases that were admitted for treatment of their occupational eye injuries. There was no statistically significant difference in the demographic characteristics of the two groups (data not shown).

In summary, this is the first study to identify risk factors for occupational eye injuries in Taiwan. It is informative for the development of prevention strategies against occupational eye injuries. However, the small sample size and hospital-based design are limitations of this study.

REFERENCES

1. National Eye Institute. Reduce occupational eye injuries resulting in lost work days. In: *Healthy Vision 2010.* National Institute Of Health, Department of Health and Human Services, USA. Available at: http://www.healthyvision2010.nei.nih.gov/safety/injury.asp [Date accessed: January 8, 2007]
2. Lipscomb HJ. Effectiveness of interventions to prevent work related eye injuries. *Am J Prev Med* 2000;18:27–32.
3. Ho CK, Yen YL, Chang CH, et al. Epidemiologic study on work-related eye injuries in Kaohsiung, Taiwan. *Kaohsiung J Med Sci* 2007;23:463–9.
4. Kochan TA, Smith M, Wells JC, et al. Human resource strategies and contingent workers: the case of safety and health in the petrochemical industry. *Hum Resour Manag* 1994;33:55–7.
5. von Hippel C, Mangum SL, Greenberger DB, et al. Temporary employment: can organization and employees both win? *Acad Manag Execu J* 1997;11:93–104.
6. O'Toole M. The relationship between employee's perceptions of safety and organizational culture. *J Saf Res* 2002;33:231–43.
7. Karen AB, Willis PG, Prussia GE. Predicting safe employee behavior in the steel industry: development and test of a socio-technical model. *J Oper Manag* 2000; 18:445–65.
8. Bailey C. Using perception survey to assess safety system effectiveness. *Prof Saf* 1989;2:22–6.
9. Bailey C. Managerial factors related to safety program effectiveness: an update on the Minnesota Perception Survey. *Prof Saf* 1997;8:33–5.

職業性眼睛外傷預防對策之病例對照研究

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台灣地區職業性眼睛外傷之防治對策研究尚未見發表，本研究透過病例對照的流行病學研究方法，針對職業性眼睛外傷個案，分析意外傷害防制之認知態度與行為，以了解未來建立預防對策時要考慮的關鍵因素。根據研究對象，包括病例組 **31** 人對照組 **62** 人，問卷調查發現，在工作中病例組有 **80.6%**，對照組有 **62.7%** 沒有戴安全眼鏡。職業性眼睛傷害的主要危險因子為：(**1**) 無固定雇主 (**OR = 10.7**，**95% CI**、**3.03－36.16**) 與 (**2**) 國中以下教育程度 (**OR = 4.44**，**95% CI**、**1.73－11.44**)。本研究以邏輯回歸分析建立職業性眼睛傷害之預測模式，主要的預測因子包括 (**1**) 是否有固定雇主 (**2**) 是否為國中以下教育程度 (**3**) 現場工業安全衛生管理良劣 (**4**) 個人對意外事故預防之態度等。本研究建議，台灣職業性眼睛外傷防治的重要因素，除了應包括強制於工作場所戴護目鏡之外，教育訓練與安全衛生管理，以及營造一個工作場所良好的安全衛生文化等等均是成功的關鍵。

關鍵詞：態度，知識，職業性眼睛外傷，行為，臨時工
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